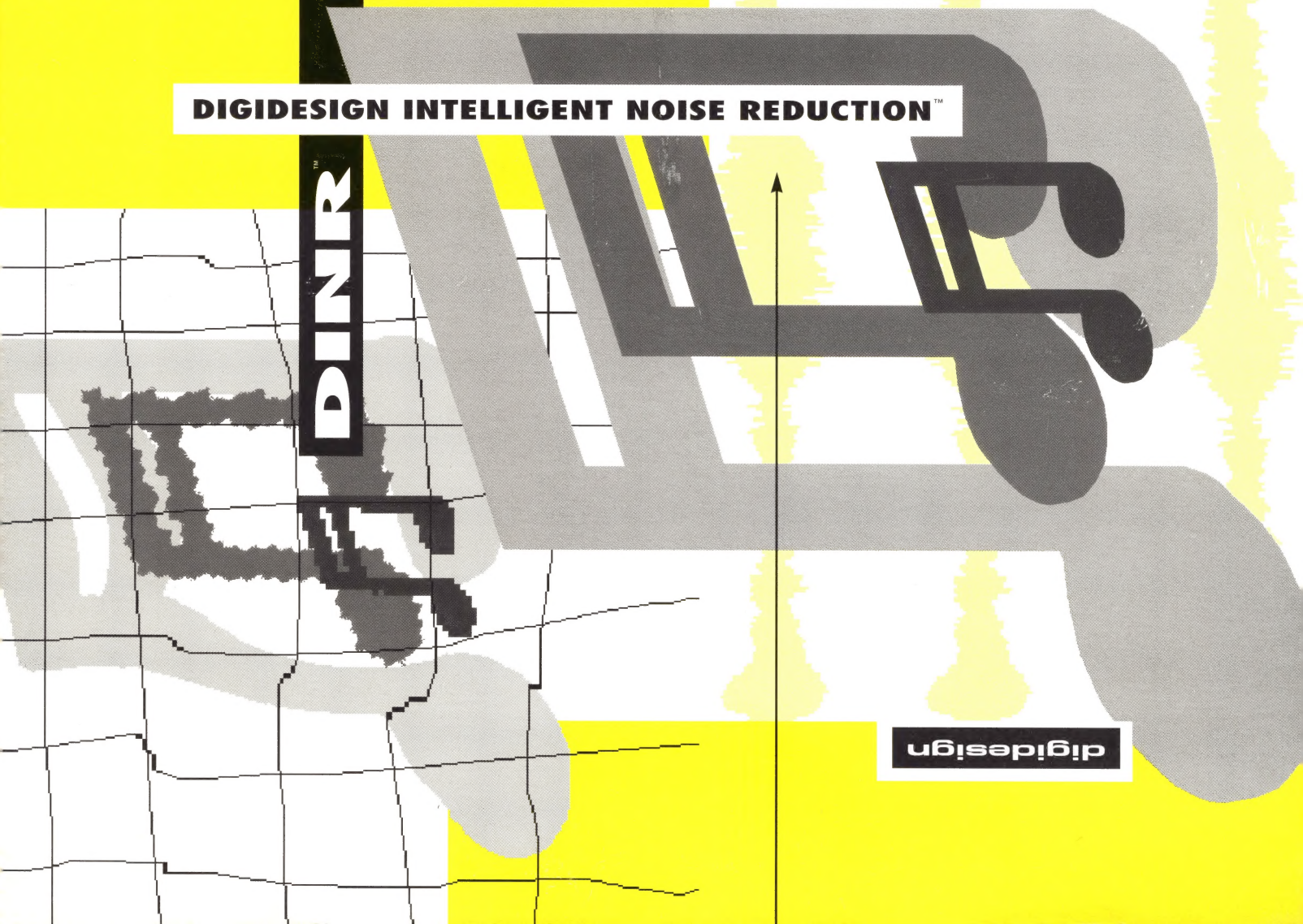
DIGIDESIGN INTELLIGENT NOISE REDUCTION™

DINR™



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DINR™

DIGIDESIGN
INTELLIGENT NOISE REDUCTION

USER'S GUIDE

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Digidesign is made up of people who are very interested in audio and the recording process as a whole. Become one of our registered owners and participate in the creative process.

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Chapter A
Installing DINR

Introduction

Welcome to Digidesign Intelligent Noise Reduction™ (DINR). DINR is a powerful software "plug-in" module for Digidesign's Sound Designer II™ software. DINR adds extraordinary noise reduction capabilities to your Digidesign digital recording and editing system. With it, cleaning up and restoring audio—a traditionally time consuming and expensive task—is now extremely fast, simple, and affordable.

DINR excels at removing two specific types of noise from recordings: "broadband" noise (such as tape hiss and preamp noise) and "pitched" or hum-based noise (such as AC line hum and guitar pickup noise). Whatever your application, you will find DINR an indispensable tool in your professional recording projects.

Before you begin to use DINR, you should already have a good working knowledge of the Macintosh computer and Digidesign's Sound Designer II digital recording and editing software. If you are not completely familiar with both of these, take the time to review their operation before going any further.

About Plug-ins

Sound Designer II version 2.4 and above is capable of recognizing and using what are called "plug-in DSP modules", such as DINR. A plug-in is essentially special purpose software that Sound Designer II reads in and uses to add new functionality to the program. In DINR's case, after you properly install this software on your hard disk, you will see two new items in Sound Designer II's DSP menu: *Broadband Noise Reduction* and *Hum Removal*. Both of these plug-in functions are stored in the single DINR plug-in module disk file.

This type of plug-in functionality is a unique advantage of Digidesign's modular approach to the digital workstation. It is central to the Digidesign philosophy of creating powerful yet affordable tools that continue to grow in functionality along with the needs of our users.

More of these special purpose plug-ins will become available from Digidesign and its developers in the future. As a registered user, we welcome your feedback on how we can continue to best serve your specific audio production needs with these products.

System Requirements

In order to use DINR, you must have the following:

- A Macintosh II™, Quadra™, or Performa 600™ computer
- Digidesign Sound Designer II, Version 2.4 or above
- Apple's System 7.0 or above

- Apple's QuickTime™ software (included with DINR)
- One of the following Digidesign digital recording and editing systems:

    a) Digidesign Pro Tools™

    b) Digidesign Sound Tools ProMaster 20™

    c) Digidesign Sound Tools II™

Installing DINR

Installing DINR takes only a few moments. The first time you use DINR, you will be required to enter the serial number that is printed on your Master Program disk. After you have finished installing the DINR software, please store your Master Program disk in a safe place.

To install DINR:

- Make sure you are running System 7.0 or above. If you are currently running System 7.0 or 7.01, install the System 7 Tuner v 1.1.1 (incuded with DINR). Do this ONLY for System 7.0 or 7.01.
- Make sure that Sound Designer II version 2.4 or above is installed on your computer.
- In the same folder that the Sound Designer II application is in, create a folder named *SDII Plug-Ins*. Copy the DINR file from its Master disk into this SDII Plug-Ins folder. It is ESSENTIAL that DINR reside in this folder (with this exact location and name) or Sound Designer II will not find it!

- From the QuickTime disk, copy QuickTime into the Extensions folder within your System Folder.

- Double-click the Sound Designer II application to start it. When it locates the plug-ins folder, it will ask you to "install" the DINR modules. A dialog will appear asking for your name, your company or business name, and the serial number printed on the DINR Master Program disk.

- Enter all three pieces of information, making sure to enter the serial number exactly as it is written on the Master Program disk. Next, click on the *Install* button.

- To complete the installation process, Sound Designer II will prompt you to insert the DINR Master Program disk into your floppy disk drive. When Sound Designer II recognizes the Master disk, it will complete the installation process and open the program.

If you cancel the installation process at any point, or if you have entered the incorrect serial number, the plug-in module's names will still appear in the DSP menu, but if you choose one of these items, Sound Designer II will alert you that they have not been properly installed. You can quit and restart Sound Designer II at any time to re-install DINR.

Once DINR has been installed, it will not require re-installation unless you use a different version of Sound Designer II or DINR. If you recopy the plug-in module from its Master Disk, Sound Designer II will ask you to re-enter your DINR serial number. You can perform disk backups and disk optimizations without having to re-install the plug-in module.

Do not lose or alter your Master Program disk in any way! You will not be able to complete an installation without it. Keep the disk locked to avoid any accidents, and store it in a safe place.

Troubleshooting

If you have gone through the DINR installation procedure and DINR does not seem to be working, please refer to the following section.

1. DINR installation dialog does not appear or DINR items do not appear in the Sound Designer II DSP menu

If QuickTime has not been properly installed, Sound Designer II will not be able to find or use DINR. Make sure that QuickTime is in the Extensions folder within the System folder. Restart your Macintosh to allow it to use the QuickTime extension.

2. "Function Not Installed Properly" dialog appears

If the names of the DINR modules appear in SDII's DSP menu, but when you select one of them an alert dialog appears, saying "This function has not been properly installed", you must re-install the DINR software as described in the beginning of this manual.

This could happen if you hit *Cancel* during the installation process, or if you used an incorrect serial number or Master Disk. If this occurs, copy the DINR software from the Master Disk again and repeat the installation process.

3. "DINR™ will not run on the currently selected type of DSP card!" dialog appears

If the DINR windows appear when their names are selected from the DSP menu, but a message such as "DINR will not run on the currently selected type of DSP card!" appears when you try to use DINR, you must verify that you have the proper type of Digidesign DSP card in your system.

DINR will only run on DSP cards that accompany Digidesign's Pro Tools, ProMaster 20, or Sound Tools II systems. DINR will not run on DSP cards for the original Sound Tools or Audiomedia systems. If you have a valid card in your system, make sure that it is selected in Sound Designer II's *Hardware Setup* dialog in the Setup menu.

Chapter B
Broadband Noise Reduction

Introduction

DINR's Broadband Noise Reduction module is designed to remove many types of broadband and narrow-band noise from program material. It's best suited to removing noise whose overall character doesn't change very much, such as tape hiss, air conditioner rumble, microphone preamp noise, etc. In cases where recorded material contains several types of noise, the necessary portions of the audio can be processed differently and independently.

DINR can operate "non-destructively" during real time playback (while recording to DAT or other device), or it can be used "destructively" to permanently remove noise from audio by rewriting the file to disk.

DINR can be used on mono or stereo audio files that range from 8 to 24 bits in resolution, and at sample rates up to 48 kHz. All of DINR's controls operate in real time, too, allowing you to instantly hear the effect of any changes that you make.

How Does Broadband Noise Reduction Work?

DINR's Broadband Noise Reduction portion uses a proprietary technique called *Dynamic Audio Signal Modeling*™. The computer, using audio information and feedback from the user, builds an internal dynamic model, or parametric description of what the noise "looks" like. At the same time, it also creates a model of the what the "desired" audio looks like. DINR then attempts to "pull apart" these two models, separating the bad from the good—the noise from the desired audio. The noise portion can then be reduced or eliminated by the user.

It is important to understand that there is a certain amount of trade-off inherent in any type of noise reduction. The process of implementing noise reduction requires that the user choose the best balance of the following three things:

- The amount of *noise* removed from the signal
- The amount of *signal* removed from the signal
- The amount of *artifacts* added to the signal

DINR gives you control of the above three parameters, and allows you to maximize the amount of noise reduction while minimizing signal loss and artifact generation. However, the final responsibility lies with the user to determine what "sounds best".

It also is important to be aware of the psychoacoustic effects of broadband noise reduction. When broadband noise is removed from most musical material, a loss of high frequencies will generally be perceived by most listeners. Most of this loss, however, is due to the broadband noise, and not the original signal. The extra noise in the higher frequency ranges fools the ear into thinking that the original signal also has a lot of energy in the same frequency ranges.

DINR's Limitations

As powerful as it is, DINR does have limitations. In particular, there are two cases in which DINR will not yield significant results:

1. Cases in which the noise components of the audio are so prominent that they obscure the actual signal components of the audio.

2. Cases in which noise amplitude of a 24-bit file is less than -96dB. DINR is not designed to see noise that is lower than this level.

Broadband Noise Reduction Parameters and Controls

To use DINR's Broadband Noise Reduction module, simply select it from Sound Designer II's DSP menu. The Broadband Noise Reduction window will then appear with a frequency domain graphical display (called the *Spectral Graph*) and several parameters which can be set with slider-type controls. The following section describes these parameters and their use.

Before you learn the particulars of DINR's Broadband Noise Reduction parameters, you should know the general procedure for using DINR:

1. First, select a segment of noise in the audio file. Ideally, the selection should be made up of noise only, and not signal.

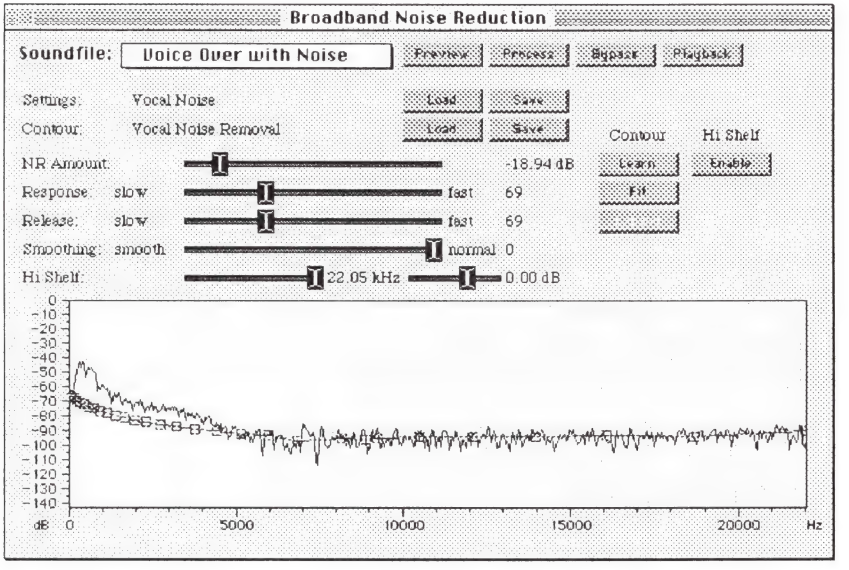
2. Next, have DINR "learn" the noise. DINR then creates a model of the noise, referred to as the noise's "signature".

3. Have DINR "fit" an editable envelope called the "Contour Line" to the noise signature.

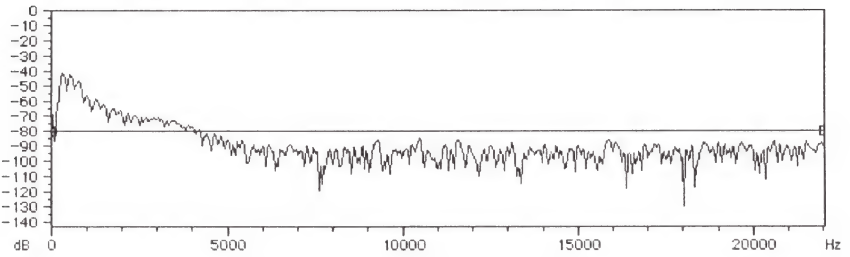
4. Select the audio segment you wish to remove the noise from.

5. Adjust the DINR controls to remove the noise.

Now, move on to the next section to get acquainted with DINR's broadband noise reduction parameters.



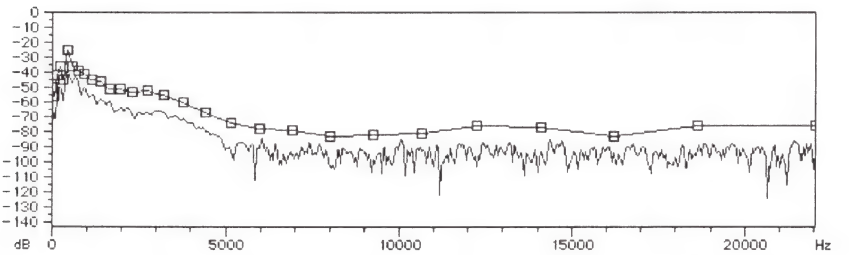
The Spectral Graph Display



The graphical display window shown above is called the *Spectral Graph* . It shows spectral information from the noise modeling process. The *Spectral Graph* has two axes. The horizontal axis shows frequency, and is displayed in Hertz, from 0 Hz to one-half the current audio file's sample rate. The vertical axis shows amplitude, and is displayed in dB, from 0 dB to -140 dB (below full-scale output of the audio).

The jagged line in the above illustration is a graph of the noise and is called the *noise signature*. It has been "learned" by selecting a segment of noise in Sound Designer II's main waveform window and then clicking the *Learn* button in the Broadband Noise Reduction window.

The Contour Line



The second graph in the illustration on the previous page, which appears as a line with a series of "breakpoint" boxes, is called the *Contour Line.* The Contour Line is created by clicking the *Fit* button in the Broadband Noise Reduction window (after you have "learned" a section of noise).

The Contour Line is essentially an editable envelope which represents the division between the noise and the desired signal in the current audio file. By moving this envelope up or down, or by moving the breakpoints and changing the envelope, the user can help the modeling process determine what is noise and what is the desired signal. This will have the effect of changing the character of the noise reduction.

The modeling process treats sounds that are below the line as mostly noise. It treats sounds that are above the line as mostly signal. Therefore, in order to maximize noise reduction and minimize signal loss, the Contour Line should be *above* any noise components that you can see, but *below* as much of the signal components as you can see.

Slider controls

NR Amount

The *NR Amount* control specifies the amount of noise reduction that is to take place. It is calibrated in dB. A setting of 0 dB specifies no noise reduction. Increasingly negative amounts specify more noise reduction. A setting of -∞ dB, will remove the noise entirely. The default value is 0 dB (no noise reduction).

Generally speaking, 20-30dB of noise reduction is not uncommon. However, because higher amounts of noise reduction tend to generate more artifacts, setting the *NR Amount* slider to -∞ is probably not always the best solution.

Response

The *Response* control adjusts how the modeling process responds to the overall changes in the noise. Depending on the character of the noise, different settings of this control will produce varying amounts of artifacts in the signal, as the modeling process attempts to "follow" the noise signal and model its behavior.

The *Response* control settings are calibrated in terms of speed, from *slow* to *fast*. A setting of *slow* specifies that the modeling process should *not* attempt to track very fast changes in the noise character. A setting of *fast* specifies that the modeling process should attempt to follow every change in the noise character very closely. A faster setting will allow more noise removal, but may generate more artifacts. A slower setting will allow slightly less noise removal, but will generate much fewer artifacts. The default value is 75.

Release

The *Release* control is used in conjunction with the Response control. It tells the modeling process how "tightly" it should try to track and recover from changes it sees in the noise's character. The *Release* control's settings range from *slow* to *fast*, indicating the speed at which the model will attempt to recover from changes in the noise. The trade-offs are similar to those described for the *Response* control above. The default value is 75.

Smoothing

The *Smoothing* control allows the user to reduce the audibility of any artifacts that are generated in the modeling process, at the expense of noise reduction. Settings range from *smooth* to *normal*. A setting of *normal* specifies no smoothing applied at all. A setting of *Smooth* specifies the greatest amount of smoothing applied to any artifacts generated. The default value is 0 (normal).

Hi Shelf

The *Hi Shelf* filter is a proprietary type of noiseless filter that can be applied after noise reduction has occurred. It is unique because it operates only on the signal, and *not* on the noise!

You can set the center frequency of the filter with the left slider. Values range from 0 Hz to one-half the sampling rate of the current audio file. The default value is one-half the sampling rate.

You can set the gain of the filter with the right slider. Values range from -12 dB to +6 dB. The default value is 0.0 dB.

The Hi Shelf filter can be turned off by clicking off the *Enable* button (located under the *Hi Shelf* heading).

The Hi Shelf filter can be used to restore some of the "sparkle", or high end to audio files that have lost some in the noise reduction process. Because the Hi Shelf filter boosts *only* the signal and not the noise, you will hear absolutely no increase in noise level.

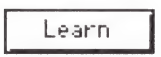
Conversely, if you have an old recording which is band-limited to begin with, you can use the High Shelf filter to reduce the amount of high frequencies (since they are probably made up of

noise and not signal anyway), without any artifact generation.

Since these two sliders are relatively short, but have a large range of values, we recommended that you hold down the Option key while dragging either of these sliders for finer control.

Button Controls

Learn



The *Learn* button analyzes audio selected in Sound Designer II's main Waveform window. If you no audio is currently selected, it will automatically analyze a small portion of audio at the current insertion point. If the current audio file is stereo, DINR will analyze the left channel of the file. DINR builds noise and sound models from the data of this analysis, and then draws the *noise signature,* which is a representation of some of these parameters.

Fit

The *Fit* button will compute the Contour Line so it "fits" the shape of the current noise signature. It automatically fits approximately 30 breakpoints to the curve. The Contour Line can then be edited by dragging, adding and deleting the square breakpoints. Pressing the + or - keys allow you to raise or lower the entire envelope, or a selected portion of the envelope.

If you hold down the **Option Key** while pressing the *Fit* button, an "exact-match" fit will be performed by DINR. Instead of 30

breakpoints, approximately 500 breakpoints will be fitted to the shape of the noise signature to follow its shape more precisely.

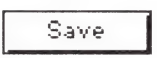
After you use the *Fit* function, DINR will automatically boost the entire Contour Line 6 dB above the noise signature, so that all noise components of the audio file are below the Contour Line.

Expand

The *Expand* button becomes active only when a selection has been made in the Spectral Graph Display. Pressing *Expand* will compute a generic noise curve based on the points contained within the selection, and then fit the Contour Line to it. This function is very useful for generating noise curves when your audio file lacks a noise-only portion for DINR to learn. If the selection of audio that was learned has both noise and sound components to it, you can generate an *approximate* noise-only Contour Line from it by selecting a frequency range that appears to be mostly noise, and pressing the *Expand* button. You can then edit the Contour Line's envelope and fine tune the noise modeling to optimize DINR's noise reduction for the audio file.

To make a selection in Spectral Graph Display you must first hold down the Command key, then click and drag the mouse.

Save



There are two *Save* Buttons. One is for saving the current Contour Line, and the other is for saving the current slider settings. By saving these parameters, you can conveniently create "noise reduction templates" that can be loaded at any time for specific noise reduction tasks, such as removing tape hiss, preamp noise, and other applications.

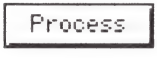
Load

The *Load* buttons allow the user to recall either slider settings or Contour Line files previously created with the *Save* buttons.

Preview

The *Preview* button will loop through as much of the selected audio as is in RAM, running the current DSP process non-destructively on the audio at the same time. If no selection exists, playback begins from the current insertion point in the Waveform window. Unlike the other Sound Designer II DSP functions, there is no built-in sample rate conversion during preview. If the sample rate of your soundfile does not match the sample rate of your playback I/O hardware, you will hear the soundfile previewed at an incorrect pitch. This does not affect processing.

Process



The *Process* button will destructively process the selected audio data with the current DSP process and settings by rewriting it to disk. If you have not selected a particular section of audio within the file, the *entire* sound file will be processed. If you have chosen *Create Undo File* in the Edit menu, Sound Designer II will try to create an undo file before it rewrites the file so that the process can be undone. Without sufficient disk space, however, Sound Designer II will not be able to create an Undo file.

Bypass

The *Bypass* button will bypass the current DSP process during *Preview*, providing an effect in/out control for auditioning the noise reduction.

Playback

The *Playback* button is equivalent to the *Use For Playback* option in other Sound Designer II DSP function windows. When enabled, this button causes the current DSP process to be applied *non-destructively* when playback occurs in Sound Designer II. The name of the current DSP process being used for playback has a diamond mark to the left of its name in the DSP menu.

Mouse controls

Clicking on the Contour Line will create a new breakpoint. Clicking and dragging on a breakpoint on the Contour Line will allow you to move the breakpoint to a new position.

Option-clicking the mouse button on a breakpoint will delete the existing breakpoint on the Contour Line. As long as mouse buttons is down it will delete all breakpoints that the mouse passes over.

Command-clicking and dragging the mouse in the Spectral Graph Display will allow the user to make a selection in the graph. A selection can be removed by Command-clicking once in the Spectral Graph Display.

Keyboard Controls

Plus Key

The Plus Key (+) will cause the Spectral Graph to zoom in horizontally by a factor of 2 each time it is pressed. If you make a selection in the Spectral Graph Display and then press the Plus key, the display scrolls to the beginning of the selection.

Minus Key

The Minus Key (-) will cause the Spectral Graph to zoom out horizontally by a factor of 2 each time it is pressed.

Left Arrow Key

The Left Arrow Key (<—) will scroll the Spectral Graph to the left if it is zoomed in.

Right Arrow Key

The Right Arrow Key (—>) will scroll the Spectral Graph to the right if it is zoomed in.

Up Arrow

The Up Arrow Key will move the entire Contour Line up by 1 dB each time it is pressed. If you make a selection in the Spectral Graph Display and then press the Up Arrow, only those points within the selection will move upwards.

Down Arrow

The Down Arrow Key will move the entire Contour Line down by 1 dB each time it is pressed. If you make a selection in the Spectral Graph Display and then press the Down Arrow, only those points within the selection will move downwards.

Performing Broadband Noise Reduction

Now that you are familiar with the Broadband Noise Reduction module's parameters and controls, you will learn how to use these functions to perform noise reduction on audio files. Before you begin, start Sound Designer II and open an audio file that contains broadband-type noise. Then:

To remove broadband noise from an audio file:

- Select a small (1/10 to 1/2 second) portion of the sound file that is all or mostly noise. If you cannot find a section of the audio that is made up of just noise, use a quiet passage where the noise is prominent.

- Select *Broadband Noise Reduction* from Sound Designer II's DSP menu. The Broadband Noise Reduction window will appear with the current sound file selected in the Soundfile pop-up menu.

- Click the *Learn* button. After a few seconds, the program will draw a noise signature in the Spectral Graph Display that represents the selected audio data.

- Press the *Fit* button. The program will fit the Contour Line to the noise signature that you just computed.

- Go back to Sound Designer II's main Waveform window (you can use the *Display* menu to switch between windows), and select a small (5-10 second) section of audio that you want to noise reduce. Alternately, scroll to the general area you want to process and click the mouse to place the insertion point there.

- Go back to the Broadband Noise Reduction window and click the *Preview* button. Playback of the selected audio will begin.

- Adjust the *NR Amount* slider to reduce the noise by the desired amount. To compare the audio with and without noise reduction, click the *Bypass* button.

- To fine tune the effects of the noise reduction, try adjusting the *Response, Release,* and *Smoothing* sliders to achieve optimal results. You can also edit the contour of the noise line using the mouse or the arrow keys during real time playback to preview the effects of the noise reduction.

- If you feel that some of the "sparkle", or high end of the audio has been lost in the noise reduction process, you may wish to try adjusting the *Hi Shelf* control to restore some of this.

When you have achieved the results you desire, you have the option of using the noise reduction *destructively* (permanently removing the noise by rewriting the data) or *non-destructively* (using the noise reduction for playback only).

To remove noise from selected audio during playback ONLY:

- Click the *Playback* button near the top of the broadband noise reduction window.

- Begin playback of the audio.

Noise reduction will now be engaged only during playback of the file. If you wish, you can now re-master the audio in its noise-reduced form to DAT or other digital medium and still keep the original, unaltered audio on disk

To PERMANENTLY remove noise from selected audio:

- Click the *Process* button near the top of the broadband noise reduction window.

If audio data is currently selected in Sound Designer II's main Waveform window, DINR will process *only* the selected audio. If no audio is selected, DINR will process the *entire* audio file. DINR will rewrite the audio data to disk, removing the noise according to the settings you have chosen. Please remember that this process will permanently rewrite the audio data on disk!

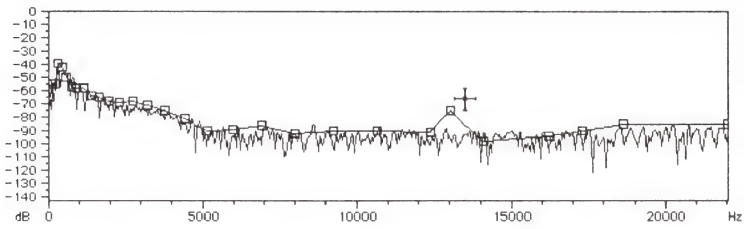
Editing the Contour Line

As you know, DINR's Contour Line represents an editable graph of the current audio file's noise signature. DINR's modeling process treats sound that is below the Contour Line as mostly noise. It treats sound that is above the line as mostly signal. In order to maximize noise reduction and minimize signal loss, the Contour Line should be *above* any noise components that you can see, but *below* as much of the signal components as you can see.

It is useful in many cases to adjust the envelope of the Contour Line in order to fine tune DINR's broadband noise reduction. This is particularly useful in cases where the noise signature that DINR has learned actually has some signal components in it. Naturally, your goal should be to remove as little signal as possible. By carefully editing the Contour Line, you can fine tune DINR's noise reduction with a remarkable amount of control to achieve exactly the results you desire.

A particularly fast and effective way to do this is to edit the Contour Line while audio is playing back (just click the *Preview*

button). This way you can monitor the effects of your changes in real time. The Plus (+) and Minus (-) keys are also very useful tools which allow you to zoom in and out on the Contour Line for more precise editing.



Editing the Contour Line

To edit the Contour Line:

- Click the mouse on one of the breakpoints and drag it to the desired location.
- To move the entire envelope (or a selected portion of the envelope) up 1 dB at a time, press the Up Arrow key.
- To move the entire envelope (or a selected portion of the envelope) down 1 dB at a time, press the Down Arrow key.

DINR also allows you to add or subtract breakpoints from a Contour Line to enhance your editing control.

To add breakpoints to the Contour Line:

- Click on the Contour Line at the point that you wish to add a new breakpoint. A new breakpoint appears at that location.

To remove breakpoints from the Contour Line:

- Hold down the Option key and click on the breakpoint that you wish to remove. The breakpoint is removed.
- To remove several breakpoints at once, hold down the Option key and drag the mouse across several breakpoints. The breakpoints are removed.

Performing Noise Reduction on Files that Lack a "Noise-Only" Portion

Ideally, every audio file that you wish to perform noise reduction on will have a noise-only portion at the beginning or end of the recording which DINR can analyze and learn. Unfortunately this is not always the case, and in many recordings some amount of signal is always mixed with the noise. Obviously, analyzing such audio will produce a noise signature that is based partially on signal. Luckily, DINR has provisions for cases like this, and this is where the *Expand* feature comes in.

As you learned earlier, if you make a selection in the Spectral Graph Display and then click the *Expand* button, DINR will compute a generic noise curve. DINR then creates a Contour Line based on your selection and the generic noise curve. If your audio file has no noise-only portion for DINR to analyze, you can still obtain fairly reasonable results by selecting and learning a segment of audio which has a relatively *low* amount of signal and a *high* amount of noise (as in a quiet passage). By then selecting a frequency range using the Expand function to generate a generic noise curve generating

To expand the Contour Line:

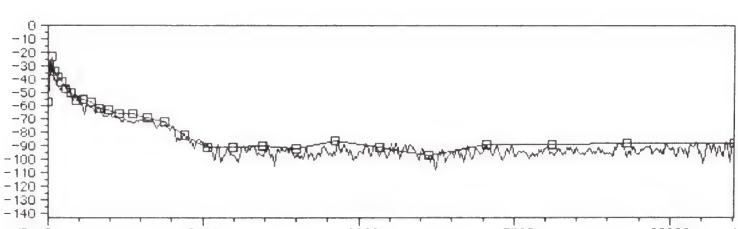
- Make sure you have learned a segment of audio with a relatively low amount of signal and high amount of noise and fit a Contour Line to it.

- Make a selection in the Spectral Graph Display by holding down the Command key, clicking and dragging the mouse to the right or left.

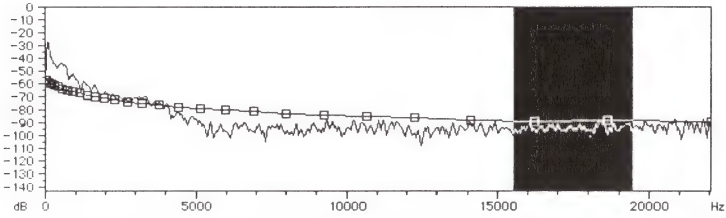
- Click the *Expand* button. DINR then computes a generic noise curve and corresponding Contour Line based on this selection. (If you wish to remove your selection in the Spectral Graph Display, hold down the Command key and click once.)

At this point, since the Contour Line is not based entirely on noise from your audio file, you will probably want to edit the Contour Line's envelope. To do this most effectively, click the *Preview* button and edit the envelope while audio plays back. You will then be able to hear the effect of your changes as you make them.

DINR previews any audio which is currently selected in Sound Designer II's main Waveform window. If there is no selection, DINR will preview from the current insertion point.



A Contour Line based on an audio selection known to contain signal.



Making a selection in the Spectral Graph Display and recomputing the Contour Line (based on a generic noise curve) with the Expand function. Note the difference in the shape of the Contour Line. Some editing of this line will probably be necessary to yield optimum results.

Saving and Loading DINR Settings

In the course of using DINR, you will probably find parameter settings that work particularly well in certain recording scenarios. For instance, you may find a group of settings that work well for removing air conditioner noise from a vocal recording. DINR's *Save* and *Load* functions conveniently allow you to save these settings and recall them for later use as needed.

In addition to control settings, DINR also allows you to save and recall Contour Lines, as well. This is particularly useful in cases where you wish to save a representative noise signature for a particular type of noise. For example, if you have a noisy mixer, or other device with noisy preamps, you may wish to specifically record the noise produced by that device, learn its noise signature with DINR, and create a corresponding Contour Line. The Contour Line can then be saved and used to remove the device's noise from any recording done with it.

To save the current Broadband Noise control settings or Contour Line:

- Click the *Save* button located to the right the desired item. A dialog appears asking you to name the file.
- Enter a name and click *Save*.

Your control settings or Contour Line can now be recalled from disk and used at any time.

To load a set of previously saved control settings or Contour line:

- Click the *Load* button located to the right of the desired item. A dialog appears asking you to locate the file.
- Locate the file and click *Open*. DINR then loads the file.

This concludes DINR's Broadband noise reduction functions. To learn how to use DINR's other module, Hum Removal Noise Reduction, please read the next chapter.

Chapter C
Hum Removal

Introduction

DINR's Hum Removal module is designed to remove many types of harmonic and non-harmonic pitched noises from program material. It is especially effective on noise such as AC line hum, light dimmer buzz, generator noise, guitar pickup noise, computer monitor radiation, etc.

DINR's Hum Removal module has two modes of operation: *Dual Harmonic Filters* mode, or *Harmonic & Notch Filters* mode. These two modes are differentiated by the type of filters they feature. You will learn more about this in the next few sections.

Like DINR's Broadband Noise Reduction module, the Hum Removal module can be used "non-destructively" during real time playback (while recording to DAT or other device), or it can be used "destructively" to permanently remove noise from audio by rewriting the file to disk. All of the Hum Removal controls operate in real time, too, allowing you to instantly hear the effect of any changes that you make.

How Does Hum Removal Work?

The Hum Removal module provides two special types of filters—Harmonic filters, and Notch filters—that are specifically designed to remove the type of pitched noises described above. The following section describes how they differ.

Harmonic Filters

DINR's Harmonic filters are designed to remove harmonic pitched noises, such as AC line noise or light dimmer noise. Harmonic noise is noise that not only contains a fundamental frequency component, (as in the 60 Hz component of AC line noise), but also contains significant components at the odd and/or even harmonics of the fundamental frequency.

Noise waveforms that have any sharp edges will produce such harmonics. If you were to remove only the 60 Hz component of AC line noise, you would still hear significant amounts of noise at 120 Hz (the second harmonic), 180 Hz (the third harmonic), etc.

The harmonic filters will remove not only the fundamental frequency that they are set to, but also all odd and even harmonics of that frequency. The advantage of this type of filter is that it effectively creates 300 to 400 digital notch filters at exactly the frequencies needed to remove certain types of noises. However, while a harmonic filter is extremely efficient, it also has drawbacks.

The disadvantage to this type of filter is that it can alter the sound by imparting a "ringing" or "phase canceling" quality to the sound. The harmonic filters used in the Hum Removal module give the user the ability to choose the best balance between noise reduction and the amount of undesired sound alteration that occurs.

Notch Filters

DINR's Notch filter bank is a different type of filter set that is also used to remove pitched noise. It provides a variable number of discrete digital notch filters, whose spacing can be varied to relate or not relate to the frequency of the first notch filter. The bandwidth and attenuation of the notch filters are also adjustable. These filters are designed to remove harmonic and non-harmonic noise.

Notch filters are particularly useful for removing noises at specific frequencies. For example, if you have one noise at 80 Hz and another one at 100 Hz, you can set up two notch filters, with the base frequency at 80 Hz and a 20 Hz spacing between them. The benefit of this approach is that the notch filter will affect only the noise at 80 Hz and 100 Hz. Other frequencies in the signal will be unmodified.

In the case of harmonic noise, you may find that the signal masks the noise up to 1 kHz or so. If so, you can avoid the side effects of a harmonic filter, and use the notch filter bank to put 10 or 20 notch filters at the 60 Hz harmonics that occur above 1 kHz.

In general, DINR's notch filters give you more control of center frequency placement, bandwidth, and number of filters than do the harmonic filters. The harmonic filters, on the other hand, allow the generation of 300 to 400 filters (20 times as many as the notch filters provide) that can remove harmonic noises entirely. But again, harmonic filters may introduce some undesired modification of the signal. Which filter set you use on a particular hum removal task ultimately depends on your needs and the nature of the hum.

Using Hum Removal

To use DINR's Hum Removal module, you must first select it from Sound Designer II's DSP menu. The Hum Removal window will then appear. It has several parameters which can be set with buttons and slider-type controls. The following sections describe these parameters and their use.

Before you learn the details of DINR's Hum Removal parameters, you should know the general procedure for using Hum Removal:

1. First, select a segment of noise in the audio file. Ideally, the selection should be made up of noise only, and not signal.

2. Next, have DINR "learn" the noise. DINR then automatically sets the center frequencies of the filters to provide the maximum amount of hum removal for the selected audio.

3. Select the audio segment you wish to remove the noise from.

5. Adjust the DINR controls to remove the hum.

Now, move on to the next section to get acquainted with DINR's Hum Removal parameters.

Hum Removal Button Controls

As you know, the Hum Removal module has two modes of operation with different types of filters in each. Common to both modes are several button-based parameters. These are explained below.

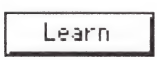
Mode

The *Mode* button allows you to select between the Hum Removal module's two modes of operation: *Dual Harmonic Filters* mode, and *Harmonic & Notch Filters* mode.

Dual Harmonic Filters mode features two completely independent harmonic filters. The second of these harmonic filters offers a wider range of base frequencies than the first. Either filter can be bypassed.

Harmonic and Notch Filters mode features one harmonic filter, plus a bank of adjustable notch filters. Either filter can be bypassed.

Learn



The *Learn* button analyzes audio selected in Sound Designer II's main Waveform window and automatically sets the center frequencies of the filters so that they provide the maximum amount of hum removal for the selected audio. The *Learn* function saves you the trouble of manually sweeping through the frequency controls in order to find the appropriate center frequencies for hum removal. If your noise contains only one hum frequency, both filters will be automatically set to the same frequency.

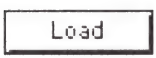
Enable

The Enable buttons allow you to turn the filters on and off so that you can listen to their effect on your audio.

Save

The Save Button allows you to save the current filter settings. By saving these parameters, you can conveniently create "noise reduction templates" that can be loaded at any time for common noise reduction tasks, such as removing AC line hum, guitar pickup noise, and other applications.

Load



The *Load* button allows you to recall control settings previously saved with the Save button.

Preview

The *Preview* button will loop through as much of the selected audio as is in RAM, running the current DSP process non-destructively on the audio at the same time. If no selection exists, playback begins from the current insertion point in the Waveform window. Unlike the other Sound Designer II DSP functions, there is no built-in sample rate conversion during preview. If the sample rate of your soundfile does not match the sample rate of your playback I/O hardware, you will hear the soundfile previewed at an incorrect pitch. This does not affect processing.

Process

The *Process* button will destructively process the selected audio data with the current DSP process and settings by rewriting it to disk. If you have not selected a particular section of audio within the file, the *entire* sound file will be processed. If you have chosen *Create Undo File* in the Edit menu, Sound Designer II will try to create an undo file before it rewrites the file so that the process can be undone. Without sufficient disk space, however, Sound Designer II will not be able to create an Undo file.

Bypass

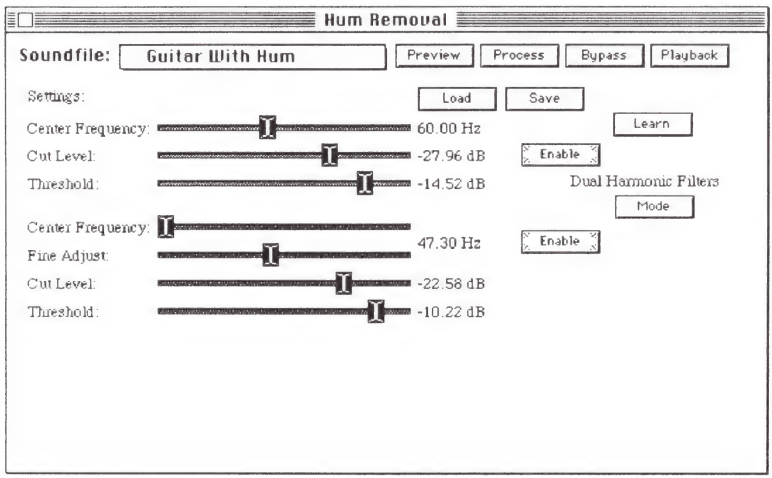
The *Bypass* button will bypass the current DSP process during *Preview*, providing an effect in/out control for auditioning the noise reduction.

Playback

The *Playback* button is equivalent to the *Use For Playback* option in other Sound Designer II DSP function windows. When enabled, this button causes the current DSP process to be applied *non-destructively* when playback occurs in Sound Designer II. The name of the current DSP process being used for playback has a diamond mark to the left of its name in the DSP menu.

Dual Harmonic Filters Mode Parameters

This section describes the controls and parameters of each of the harmonic filters in *Dual Harmonic Filter* mode.



Dual Harmonic Filters Mode

Harmonic Filter 1

Center Frequency

The *Center Frequency* control allows placement of the notches at the hum signal's fundamental frequency. Most hum has several harmonic components rather than just a single frequency. The harmonic filter notches out all of these components.

Cut Level

The *Cut Level* control determines the depth of the notches created by the harmonic filter. This allows the user to determine the amount of noise reduction to take place when the signal falls below the threshold. Higher -dB settings create deeper notches and more noise reduction. Lower -dB settings will generate less undesired alterations of the audio. A cut level of 0 dB specifies no harmonic filter at all (flat frequency response) while a cut level of -∞ gives the maximum reduction at the notches.

Threshold

The *Threshold* control allows the harmonic filter to take effect based on the level of the signal—much like an expander or noise gate. If the input signal level is *below* the threshold, the harmonic filter becomes active and the hum is reduced. When the signal level goes *above* the threshold, the harmonic filter is bypassed (since loud signals act to psychoacoustically mask the noise components).

By setting the threshold at 0 dB (the highest level) the harmonic filter is always turned on. When the signal level is below the threshold, the amount of hum reduction depends on how far below threshold the signal is. For optimum hum removal and a minimum of artifact generation, adjust the *Threshold* so that it is just above the noise level.

Harmonic Filter 2

Center Frequency

The Center Frequency control allows placement of the notches at the hum signal's fundamental frequency.

Fine Adjust

Because Harmonic Filter 2 harmonic offers a broader range of fundamental frequencies than Harmonic Filter 1, the *Fine Adjust* control allows you to pinpoint the desired frequency. To get an even finer adjustment with any slider, hold down the Option key while dragging the slider with the mouse.

Cut Level

The *Cut Level* control is identical to that of Harmonic Filter 1.

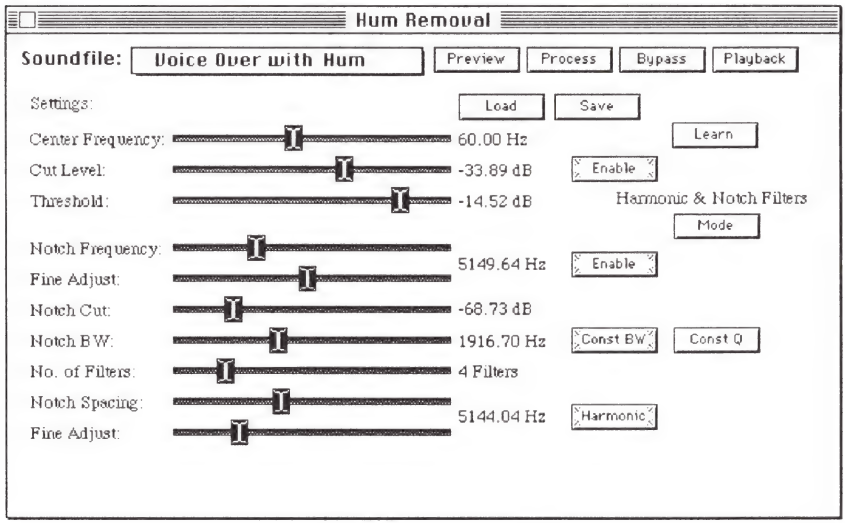
Threshold

The *Threshold* control is identical to that of Harmonic Filter 1.

Harmonic & Notch Filters Mode Parameters

This section describes the controls and parameters of each of the filters in *Harmonic & Notch Filter* mode.

The notch filter bank allows you to remove several discrete frequencies without putting notches throughout the entire spectrum, as would the harmonic filter. For example, you can put a single notch filter at 400 Hz (to remove airplane generator noise) without notching every other multiple of 400 Hz, as would occur with the harmonic filter.



Harmonic & Notch Filters Mode

Notch Frequency

The *Notch Frequency* slider determines where the center frequency of the first filter notch will be. (Subsequent filters are spaced according to the *Notch Spacing* slider.) Because the range of the *Notch Frequency* slider is rather wide (10 Hz to 18 kHz) a fine adjustment slider is provided.

Fine Adjust

The *Fine Adjust* slider allows precise adjustment of the Notch Frequency. If you need even finer adjustment, use the Option-drag technique discussed previously.

Notch Cut

The *Notch Cut* slider determines the amount of attenuation provided by each notch filter. It allows maximum attenuation (cut) at the -∞ point, and 6 dB of boost at the other extreme. This makes the notch filter bank similar to a parametric equalizer, with each filter having the same attenuation level.

Notch Bandwidth

The *Notch BW* slider determines the bandwidth, in Hz, of each notch filter when the *Const BW* (constant bandwidth) button is highlighted. There is a simple relationship between the bandwidth, center frequency, and Q (for "Quality Factor") of a notch filter:

Q = center frequency / bandwidth
or equivalently,
bandwidth = center frequency / Q

For constant bandwidth notches, the 'Q' of each filter depends on its center frequency. When the *Const Q* button is highlighted, each filter has a constant Q, and its bandwidth depends on its center frequency. A larger Q value means a sharper, narrower notch.

Number of Filters

The No. of Filters slider determines the number of notch filters that are used. The number of available filters increases if you are working with mono files and/or if the Harmonic filter is disabled.

Notch Spacing

The *Notch Spacing* slider determines how far apart (in Hz) the notch filters are spaced. With the *Harmonic* button highlighted, the notches are placed only at multiples of the Notch Center Frequency. Changing the Notch Center Frequency will then change the notch spacing. This keeps the notches at harmonic intervals, much like the harmonic filter, but creates a fewer overall number of notches. By deselecting the *Harmonic* button, you can set the spacing to *any* value between 10 Hz and 2 kHz. Once again, a fine adjustment slider is provided and the Option-drag method can be used to get "super-fine" adjustment.

Fine Adjust

The *Fine Adjust* slider allows finer adjustment of notch filter spacing in Hz.

Performing Hum Removal

Now that you are familiar with the Hum Removal module's parameters and controls, you will learn how to use these functions to perform hum removal on audio files. Before you begin, start Sound Designer II and open an audio file that contains hum-type noise. Then:

To remove hum from an audio file:

- Select a small (1/10 to 1/2 second) portion of the sound file that is all or mostly noise. If you cannot find a section of the audio that is made up of just noise, use a quiet passage where the noise is prominent.
- Select *Hum Removal* from Sound Designer II's DSP menu. The Hum Removal window will appear with the current sound file selected in the Soundfile pop-up menu.
- Click the *Mode* button to select which of the module's two modes you will use, *Dual Harmonic Filters*, or *Harmonic & Notch Filters*.
- Click the *Learn* button. After a few seconds, the program will automatically set the Center frequencies of the filters.
- Go back to Sound Designer II's main Waveform

window and select a small (5-10 second) section of audio from which you want to remove hum. Alternately, scroll to the general area you want to process and click the mouse to place the insertion point there.

- Go back to the Hum Removal window and click the *Preview* button. Playback will begin.

- Adjust the *Cut Level* slider to reduce the noise by the desired amount. To compare the audio with and without hum removal, click the *Bypass* button.

- To fine tune the effects of the hum removal, try adjusting the *Threshold*, (or in Harmonic & Notch Filters mode) Notch *Cut, Notch BW, No. of Filters, and Notch Spacing* sliders to achieve optimal results. Try doing this during real time playback to preview the effects of the hum removal.

When you have achieved the results you desire, you have the option of using the hum removal *destructively* (permanently removing the noise by rewriting the data) or *non-destructively* (using the hum removal for playback only).

To remove hum from selected audio during playback ONLY:

- Click the *Playback* button near the top of the Hum Removal window.

- Begin playback of the audio.

Noise reduction will now be engaged only during playback of the file. If you wish, you can now re-master the audio in its noise-reduced form to DAT or other digital medium and still keep the original, unaltered audio on disk

To PERMANENTLY remove hum from selected audio:

- Click the *Process* button near the top of the Hum Removal window.

If audio data is currently selected in Sound Designer II's main Waveform window, DINR will process *only* the selected audio. If no audio is selected, DINR will process the *entire* audio file. DINR will rewrite the audio data to disk, removing the noise according to the settings you have chosen. Please remember that this process will permanently rewrite the audio data on disk!

Saving and Loading Hum Removal Settings

As with DINR's Broadband Noise Reduction, you will probably find Hum Removal parameter settings that work particularly well for common hum-type noise. DINR's *Save* and *Load* functions conveniently allow you to save these settings and recall them for later use as needed.

To save the current control settings:

- Click the *Save* button at the top right of the window. A dialog appears asking you to name the file.
- Enter a name and click *Save*.

Your control settings can now be recalled from disk and used at any time.

To load a set of previously saved control settings:

- Click the *Load* button located to the right of the desired item. A dialog appears asking you to locate the file.

- Locate the file and click *Open*. DINR then loads the file.

This concludes your DINR User's Guide. We are confident that you will find the DINR software a very powerful and useful tool in your professional recording and mastering projects. To help us continue to provide you with new product information, technical support, and product updates, please make sure to send in your DINR registration card.